Distr.
LIMITED

ID/WG.435/6
14 January 1985

ENGLISH

United Nations Industrial Development Organization

Regional UNIDO/ESCAP Workshop and
National Consultations on the
Commercialization of Research
Results

Bangkok, Thailand, 15-19 October 1984

COMMERCIALIZATION OF RESEARCH RESULTS - ISSUES AND SOLUTIONS*

by

Masud A. Dahir**

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** Joint Secretary, Ministry of Production, Islamabad (Pakistan).

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BACKGROUND

Pakistan is a poor country passing through initial phase of industrialisation to provide plant, machinery and goods for the common needs of its vast population, bulk of which is involved in agriculture or services. The industrial activity is limited and so is the research and development.

2. Most of the research is being done by Government or Semi-Government agencies which have limited means. These focus on the imporvement and adoption of machines, processes, products and production systems. The research effort is not geared to the generation of technology or towards organized innovation. In fact it is at tangent to the bulk of the trade, industry, the commercial practice and the profit direction in which the trading community is involved. Even this negligible effort is circum-scribed by low levels of literacy, understanding and knowledge. Its research organizations lack direction and lose sight of the fact that research results, to be profitable, have to be embodied in products, machinery and equipments, workers skills, in all systems of production and even in systems of distribution and marketing of the products.

INFORMATION & TECHNICAL GAP

One of the important elements missing in R & D Planning and selling research is the inadequacy of business or technical information needed for this purposes. Two types of information generating functions are required for maximising the R & D effort and its sale.

(a) Profit function

To take up in-depth survey of profit oriented major Socio-technological and economic trends and identify fast growing future markets. This can be achieved by promoting free flow of problems of the industries into the R & D organization or by organizing open house laboratories, research industrial meetings, symposiums and seminars, publications and exhibitions.

(b) Marketing and economic evaluation function

Purpose is to undertake studies for

i) selection of the projects

ii) decision making, in order to determine if the results of a laboratory research are worth-while for development into pilot plant or commercial plant. This gap between the research results and commercialization is being filled by greater attention on the desing and working of pilot plant, proto types

and demonstration units.

PILOT PLANTS

However pilot plants cost probably five times more than the project cost at the laboratory stage. It is an un-avoidable step as in a phase of engineering experimentation for new products and processes, it provides a means for :-

i) Adaptation and development of technology required for a new process.

ii) Development of 'turn-key' technologies for small to medium scale industrial process.

iii) To get 'interim' production.

iv) Techno-economic analysis of the project.

v) To provide insurance against making expensive mistakes in commercial scale plant operations.

vi) To convince the entrepreneurs that the new proposal or process is sound.

vii) Studying the effect of changing raw materials, operating conditions, catalysts and for trouble shooting etc., without costly interference with production in existing commercial units.

ROLE OF THE GOVERNMENT

In poorer countries, the Government is the sole initiator of research and development within the overall Science and Technology (S&T) plan. The Governments initiative and intervention may take place in the following shapes:-

i) Establishment of a National Research Development Corporation(NRDC) e.g. U.K. India, Phillipines and Brazil where these institutions licence inventions, make available development finance or absorb losses.

ii) Private Companies are listed to use new technology and produce products which the Government procures till such time the products become economically viable. This is the U.S. approach.

iii) Government funded projects for the purpose of obtaining emperical data or production costs or product performance etc.

iv) Free leasing of the Government demonstration plants used by USA during IInd World War.

v) Fiscal incentives to stimulate in-directly commercialization of research results (CRR) e.g. in Japan one third of the purchase price

paid for plant and machineries required for (CRR) can be added to the ordinary depreciation in the first year and tax relief is provided by allowing expenditure as deductible expense. Pakistan gives limited tax incentives for CRR e.g. lower excise duty is charged on beverages using local concentrate formula. Additional incentives e.g. concesstionary loan of capital, tariff protection, liberal allocation of foreign exchange for raw-materials import will promote the CRR.

ROLE OF FINANCIAL INSTITUTION

The policies of financial institutions in Pakistan do not encourage the CRR. However, in Japan loans having long term re-payment and lower rate of interest are given by Japanese Development Bank to small and midium enterprises and Finance Corporations. Similar incentives may be provided.

INDUSTRIAL SECTOR VS ENTREPRENEURS

The industrialists and entrepreneurs are attracted towards the plants, processes and research results advertised by multi-notionals, because their effort and patent have more credibility and profit than the local R & D. One way to motivate them for using local R&D is to compel them to establish their own R&D units. Cash training grants and

tax concessions may be given to such units. Another way is to fallow and adopt the methodolgy of Korean Technology Advancement Corporatio (KTAC) which takes minorities equity position in new companies based on their invention while the management is under the direction of KTAC new Joint Venture Company.

These are very briefly the issues and solutions for promoting CRR. The best way is that each country may share its experience and adopt some of the tried methodologies in a continuing exercise for optimising the returns on CRR.

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United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.435/7
16 January 1985

ENGLISH

Regional UNIDO/ESCAP Workshop and
National Consultations on the
Commercialization of Research
Results

Bangkok, Thailand, 15-19 October 1984

UNITED NATIONS
COLLECTION

COMMERCIALIZATION OF RESEARCH RESULTS AT NATIONAL LEVEL INCLUDING LINKING MECHANISM BETWEEN INDUSTRIAL RESEARCH INSTITUTIONS AND INDUSTRY*

Prepared by**

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** Ceylon Institute of Scientific and Industrial Research (CISIR), Colombo, Sri Lanka.

V.85-20900

INTRODUCTION

The CISIR is today Sri Lanka's leading multidisciplinary research institution. The technical work of the institute is divided among the following sections :

Agro Industries
Analytical Chemistry
Applied Physics and Electronics
Environmental Monitoring and Pollution Control
Fats and Oils
Food Technology
Industrial Microbiology
Minerals Technology
Natural Products
Pilot Plant and Designs
Rubber Technology
Wood and Cellulose Technology

These Sections are staffed with about 30 senior scientists and engineers having post-graduate qualifications and in equal number of younger graduates. Provision exists for 25 more research officers but recruitment is difficult because salaries and other benefits at research institutions are lower than in manufacturing and trading organisations within the public sector itself. As a consequence staff turn-over is high. Fortunately we have been able to retain a core of qualified and experienced staff members who are willing to forego

financial advantages for job satisfaction.

The institute received for 1984 a government grant of Rs. 7 million (US $ 280,000) for current expenditure and Rs. 6 million (US $ 240,000) for capital expenditure which includes equipment, books and periodicals.

The institute was established in 1955 as a condition to the grant of a World Bank loan. The services of the first director were provided by the World Bank. He had worked at the Armour Foundation in the U.S. and had established an industrial research institute in Mexico. On the basis of this experience he was confident that if the government of Ceylon (as Sri Lanka was then known) provided a grant of Rs. 5 million in five yearly instalments of Rs. 1 million each, the institute would be self sufficient at the end of the 5 year period. In the event, however, even at the end of 5 years CISIR was earning less than 20 per cent of its expenditure. This failure was due to two main reasons. Firstly, the core staff of 6 research officers of the institute could not between themselves muster expertise in the several disciplines needed to serve industry. There was a strong bias towards chemistry while the area of engineering was weak. This imbalance has continued to the present day and is a major constraint to the development of technologies at CISIR. Secondly, industry in our country was then in its infancy and very few senior managers in industry then understood how to utilise the services that the institute provided.

The powers and duties of the institute are vested in a Governing Board which includes representatives of government ministries and private industry. In the early years of its existence the institute enjoyed a great deal of freedom. This autonomy has gradually been eroded and today many of the important decisions of the Governing Board are subject to approval by the Ministry of Industries and Scientific Affairs. The sale of technologies developed at CISIR is one of the subjects that are governed by Ministry directives.

Where the work has been commissioned and paid for by a client the rights to the exploitation of the technology including any patents belong exclusively to the client. Such an agreement was signed between the CISIR and the State Trading Corporation (Consolidated Exports) for R and D work on spices. In drafting this agreement we found a great deal of useful information in the UNIDO publication "Industrial Research Institutes" (Vienna, 1970).

Annex 3 : "Form of Agreement Between an Industrial Research Institute and A Client Sponsoring A Research Project" was particularly useful. The agreement signed by us is of the umbrella type allowing for several individual projects. A separate schedule has to be signed for each project. A schedule has recently been signed for the first project assigned under this agreement.

Technologies developed at CISIR through projects initiated at CISIR are commercialised in accordance with guidelines laid down

in Ministry directives. These require the technologies to be advertised in the newspapers and sold on a non-exclusive basis. The offers received are now scrutinised by a Contracts Committee appointed by the Governing Board which is composed of some members of the Governing Board and some senior officers - director, deputy director, head of the section which developed the technology, Chief Accountant and Head of the Section of Industrial Economics.

The criteria for the award of the rights to the technology have varied from time to time. During the period 1970 - 1977 state corporations received priority in the award of technology rights. In addition they made no payment for the technology. Not only was the institute thereby deprived of revenue rightly due to it but the officers involved in the development of the technology were denied payment of the appropriate part of the royalty normally paid to them. It also generally resulted ultimately in the non-exploitation of the technology, as happened in the case of the process for the manufacture of sodium alginate from sea weed which had been developed at the laboratory bench scale at CISIR. The institute had finalised arrangements for the sale of this technology to a private sector organisation which was already involved in the manufacture of a number of products based on local raw materials. This organisation also had links with a well known transnational corporation involved in chemical processing. The National Textile Corporation then claimed that the technology should be handed over to them on the grounds that they were the ultimate users of the alginate. The Ministry ruled that the technology should be given to the Textile Corporation. This Corporation had no experience in scaling up chemical

process as did the private sector organisation. After some attempts at scaling up had failed they abandoned the project a couple of years later. By that time there was a change of government with changes in overall economic policy. The subsequent liberation of imports led to free imports of alginate at prices which could not be matched by any local manufacturer.

It has also been our experience that sale of the technology to the highest bidder also has serious limitations. The following case explains this statement. A client brought a sample of coconut paste made abroad and asked whether the institute could make a product to match. We were in the happy position to inform him that just such a product had recently been developed at CISIR. The client offered terms for purchase of the technology. Being debarred from accepting this offer directly the Contracts Committee sought direction from the Governing Board. The Board decided that normal procedure should be followed and the process advertised. Among the responses to the advertisement was one which offered much higher payment than the earlier client had offered. By the time the decision was made to offer the process to the higher bidder the latter had lost interest in this process and invested his money in a venture that held out higher financial rewards. When the process was offered to the client who had first approached the instititute he replied that he had arranged to obtain the technology from other sources. The CISRI developed technology is today lying on the shelf.

Another problem we have encountered is that of granting exclusive rights to use a CISIR-developed technology. The Ministry had

earlier directed CISIR to advertise all CISIR processes on the basis of non-exclusive manufacturing rights on the grounds that as a government sponsored organisation CISIR should make its processes readily available to all industrialists and entrepreneurs on the same basis of payment. Some processes are however difficult to sell on a non-exclusive basis. The market is sometimes too small to support more than one manufacturing unit. Sri Lanka has a population of 15 million and a Per Capita GNP of about US $ 284 at current prices. The product itself may be new and has to be introduced into the market. No industrialist would be willing to spend on advertising a new product and bestow the benefits of his pioneering labours free of charge on a competitor entering the field. The grant of exclusive use of CISIR-developed technologies on an exclusive basis for a limited period of a few years is therefore considered in the above cases. The advertisement now carries the following clause :

> "The policy of the Institute is to offer the process it has developed for sale on a non-exclusive basis. However, applications for exclusive purchase of CISIR technologies for limited periods will be considered in special cases".

A major problem faced by the institute in collecting the royalties due to it is caused by our inability to investigate infringements of our rights. Sometimes a small manufacturer may pay us royalties for a couple of months for use of know how he has obtained from us. Then he informs the institute that he is no longer using the know how he has obtained from us as he has obtained improved technology from

elsewhere. We are therfore now forced into the position where we do not count for certain on obtaining royalty payments but try to obtain the maximum down-payment at the time of signing the agreement.

Past experience has also shown us as it has, I believe, shown all others, that it is a risky operation to attempt pilot plant trials on one's own, particularly in the context of a liberalised economy. We therefore now proceed to pilot plant studies if the technology is simple, if we already have the equipment and if the amount of money involved is small. We now insist that once a process is developed at the laboratory bench scale that the technology so worked out must be described in a written report. Even prior to the completion of the laboratory work, when the process first appears be commercially attractive and worthy of scaling up, the engineers of the Pilot Plant Section should be invited to be associated with the project. Once the final laboratory report is ready the scientists who developed the process are required to sit down with their counterparts in the Section of Industrial Economics and prepare a report on the economic feasibility of the report. We then advertise the process inviting industrial partners for collaboration in scaling up the process. The industrialist or entrepreneur at this stage must be provided with the technical and economic feasibility reports. Any shortcomings in these evaluations are apt to put off the industrial, as we found to our cost recently. Once confidence in the institute is shaken it is a difficult task to restore it. The advantages in bringing in an industrial partner are many. Firstly, it indicates

it indicates whether the commercial prospects of the process developed are promising. If the response to the notice calling for an industrial partner is poor, proceeding to pilot plant studies on our own must be done after a most searching study The other advantages of an industrial partner include the following (1) We may already have experience of operating in the same or a related field so that the services of personnel experienced in the particular field of work are available (2) He may have the equipment or some similar equipment that can be modified for the purpose (3) The costs are both reduced and shared so that the risk borne by the institute are correspondingly reduced.

The total number of technologies developed at CISIR over the nearly thirty years of its existence has been small compared to the number of projects begun. The number of processes that have been commercialised is even fewer. I have read or heard it said that on a world-wide estimate only about one per cent of the projects begun finally result in successful commercial ventures. We believe that the greatest care should be given to the selection of research projects. Earlier each research officer or the Head of his Section chose the subject of each research project. Now after some preliminary laboratory and market investigations a formal research proposal is submitted to our Research Planning Council. This proposal must have an economic evaluation made by the Head of Section in collaboration with the Section of Industrial Economics. Formal laboratory work begins and costs are maintained only after approval of the proejct by the Research Planning Council. As earlier mentioned

a second economic evaluation of the process is made after laboratory studies are completed and a third after Pilot Plant studies.

One point I would like to emphasize is that money spent on research projects that failed to give commercial results is NOT wasted money. A great deal of useful information is obtained in the course of such studies and the research workers add to their fund of experience. Perhaps the following story concerning Thomas Alva Edison, the great American inventor would illustrate my point better.

"Thomas Edison was mocked for trying unsuccessfully some twelve hundred materials for the filament of his great dream, the incadescent light bulb. "You have failed twelve hundred times", said a regimented thinker of that day. "I have not failed", countered Edison. "I have discovered twelve hundred materials that won't work".*

Another approach suggested to our Governing Baord to the problem of exploiting industrial processes developed at CISIR is referred to as the Entrepreneur Development scheme. Here the group of R and D personnel who developed the process would be encouraged to commercially exploit the process. The institute would recommend to the development financing institution that the entrepreneur or entrepreneur group composed of the R and D staff that developed the project would be financially assisted to start and continue production.

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* James C. Humes, Speaker's Treasury of Anecdotes about the Famous (New York, Harper and Row, 1978).

The institute would continue to provide technical assistance in the way of factory trouble shooting, quality control and improvement of the technology. It is hoped by this scheme to provide incentives for determined and sustained effort in the development of technologies. Further, it has been suggested by proponents of the scheme, that no one would be as motivated in making a commercial success of a process as the person or the group of persons who developed it.

Two case studies of successful exploitation of processes developed at CISIR and two case studies of technologies that held much promise but could not be commercialised are presented at the end of this paper.

As we proceed to study the subject of transfer of technologies developed in our research institute we have come across the undermentioned questions. I hope that the discussion of these questions in this forum will provide the answers, even in a general way to the problems of technology commercialisation by institutions like our own CISIR.

(1) What should be the deciding factors in the selection of a licensee to exploit an industrial process developed at a research institute?

(2) How are the conditions of payment (both initial down-payment and recurring royalty) determined?

(3) What should be the basic features of a scheme of incentives to R and D workers for the development of industrial technologies?

CASE STUDY I

REPLACEMENT OF THE INSULATING LINING OF ELECTROLYTIC CELLS USED IN THE MANUFACTURE OF CAUSTIC SODA

The caustic soda plant established at Paranthan in the early fifties was one of the early government industrial ventures. The technology was outdated even at the time the plant was purchased from an European company which ceased operations a few years later. The plant was owned and operated by the Paranthan Chemicals Corporation. There was a delay of several years in erecting the plant and problems in commissioning it. Shortly afterwards it was found that the ebonite insulating layer was failing in a number of cells.

Each cell consisted of a grooved bar of steel as the horizontal member each end of which carried a similarly grooved member. The vertical arms were about 4 feet high while the horizontal member was about 10 feet long. The grooves were about 4 inches deep and had a thin insulating lining of ebonite. The electrolyte solution was carried in the groove. Once deterioration of the ebonite lining began the chlorine produced in the electrolyte solution attacked the steel material of the cells.

At this time the corporation being already in financial difficulties had no funds to buy new electrolytic cells nor to have the defective one reconditioned abroad. In this desperate situation the CISIR was requested to "try out anything because closure of the plant appeared imminent". At CISIR the task was handed over to the Rubber Technology Section of which I was head.

If we had a large enough autoclave to accomodate the cells laying on a new layer of ebonite would not have been too difficult a task. But we had no autoclave so large. The vulcanising condtiions for the compound we had formulated were 5 hours at 150°C.. The only alternative available to us therefore was vulcanising in hot water. On a rough calculation confirmed by laboratory trials vulcanising in (boiling) water at 100°C would need

a reaction time of 160 hours - nearly one week. Yet we had to resort to this method.

Our workshop had a car servicing pit. We built up the sides of pit to a ight of about 4 feet to give a head of about one metre of water above the electrolytic cell. To maintain the temperature above the the boiling point of water we tipped in about 50 lb. of crude common salt into the bath of water. The electrolytic cells were lowered into the bath and steam passed into the water to raise the temperature gradually to boiling point. The steam supply was then disconnected. The drop in temperature overnight was only about $3^{o}C$ and steam was therefore blown in each morning and evening to raise the temperature of the bath to boiling point. After one week the rubber composition was found to be well vulcanised and an even layer of ebonite had formed. No cracks or pinholes were detected when spark-tested. The slow vulcanising over a number of days had permitted the dissipation of the heat evolved during the strongly exothermic reaction producing ebonite. Since the ebonite layer was to function as electrical insulation cracks or pinholes could not be tolerated.

Our institute is located in Colombo while the caustic soda plant was at Paranthan about 250 miles away. A lorry could only bring four cell frames at a time as they were quite heavy. We therefore decided to obviate the transport costs by moving the cell-relining process to Paranthan in two stages. In the first stage a concrete vulcanising tank was constructed with a steel lid that could be bottled down. Sheets of rubber compound were made at CISIR and sent by train to Paranthan. At the second stage arrangements were made with a tyre retreading firm only a few miles away from the caustic soda plant to prepare and supply the rubber compound.

This arrangement has been working smoothly for several years now.

THE PRODUCTION OF COCONUT CREAM

The staple diet of Sri Lankans is rice and curry. The curries are nearly always made with coconut "milk" which is the water extract of grated coconut. The prepararion of the coconut milk is a tedious chore for the housewife. In addition the manual squeezing of the grated kernel with added water leaves behind about 30 per cent of the available fat in the solid residue which is thrown away as "coconut refuse" in individual households. CISIR therefore undertook a project to develop a marketable coconut cream that would lessen the tediusness of domestic cooking while at the same time extract much more of the edible fat from the coconut kernel. Centralised processing also offered the advantage of utilising the extracted meal (coconut refuse) for animal feed and the coconut shell for charcoal production.

The basic problems lay in identifying an effective yet inexpensive food stabiliser and a method of sterilising the cream while retaining its flavour. These problems were fairly well tackled and a hygienic and nutritious bottled coconut cream market tested. It received the approval of the Housewives Association. Pilot plant studies were initiated at a desiccated coconut manufacturing plant owned by the government Coconut Processing Board. In testing marketing the product however it was found that though the quality was acceptable the coconut cream did not find ready sales. The price of coconuts was low enough for everyone to afford home preparation of the coconut milk. The more affluent people had servants do their cooking.

In 1982 however an industrialist bought the rights to use this process with the primary aim of exporting bottled coconut cream to the Middle East countries where there were large numbers of immigrant labour from Sri Lanka and other South Asian countries. The prices of coconuts more than doubled during 1983 making the process economically viable and market

demand for the product cannot be satisfied since as yet only trial production is going on using CISIR pilot plant equipment. Just two weeks ago an article in a Sunday newspaper (on 30 September 1984) blamed the CISIR for not having sufficient quantities of this coconut cream on the market. The equipment for factory scale production is either on order from aborad or under fabrication within the country.

In the meantime a US Aid mission has spotlighted the obvious advantages to the country of centralised processing of coconut kernel to produce coconut cream to partially replace domestically prepared coconut "milk". As a result the CISIR jointly with the Coconut Research Institute has been handed the responsibility of developing a product which will be as good as the best available on the international market. Stage I of the project requires preparation of a profile of the domestically prepared coconut milk relating to chemical, physical and economic evaluation cocoaut products available in other countries that could substitute for domestic coconut "milk" and the preparation of the outline of a process to prepare such a product. This stage of the project has been almost completed.

The next stage calls for development work at pilot plant level, if necessary with assistance from institutions abroad. Our officers are visiting institutions abroad that are in a position to offer such assistance. The form that the final set-up for manufacturing coconut cream or a substitute for it is not quite clear yet. It could be based on a few very large units or it could be adjunct to several of the plants that are today manufacturing desiccated coconut. These units have established hygienic conditions in the operating areas and the equipment for manufacturing desiccated coconut is the same as that for making coconut cream up to the point of disintegrating the coconut kernel.

CASE STUDY III - CARBONATED TEA DRINK

Tea, Sri Lanka's principal foreign exchange earner, has been exported as a commodity for over a century. Since the producing countries do not have much control over the pricing of such commodities in international markets and the growing demand for tea among tourists to Sri Lanka, considerable research has been undertaken to develop new products from the tea leaf. The Ceylon Institute of Scientific and Industrial Research (CISIR) initiated research and developed on the manufacture of new products from black tea in November 1968 A laboratory process for the preparation of carbonated tea was ready in 1980 and pilot plant trials were successfully concluded.

WHAT IS CARBONATED TEA

This is a carbonated tea beverage which has been tested both locally and outside Sri Lanka and the reports obtained have been extremely favourable. It is a ready-made iced tea beverage having some of the properties of cola drinks. Such a drink should find a ready market alongside the popular colar drinks.

As compared with cola drinks, it has the following advantages :

(a) It is made form pure fermented tea (manufactured black tea or fresh fermented green tea)

(b) It contains no artificial colouring matter

(c) It contains the various constituents of tea with their therapeutic value - caffeine, vitamins, polyphenols etc.

This beverage is carbonated to give an attractive sparkle, flavoured to give a pleasant taste and filtered to a high polish. The caffeine from the tea leaf gives it refreshing and invigorating properties.

PROMOTION OF THE PROJECT

The pilot plant trials were carried out in co-operation with a leading aerated water manufacturing firm in Sri Lanka, which showed an interest in buying the process, but the CISIR being a government organisation, its Board of Directors was not agreeable to a private arrangement of this nature and decided that the process should be advertised for sale under "Business Opportunities" in the classified columns of the 'Ceylon Daily News', the national daily in the English Language having the largest circulation in the country. However there were no takers and fresh steps had to be taken to sell the process.

The next attempt to sell the process was one year later in 1971, when the CISIR wrote to nineteen firms, who seemed to have some of the facilities required for the manfuacturing process of the new product.

Tea-ko Makes its Debut

One of the smaller mineral water manufacturers was selected from the nineteen firms written to as it was felt that this firm had the facilities and equipment needed for the manufacturing process. An agreement was entered between the CISIR and this company in March 1972. The new carbonated tea drink was introduced into the Sri Lanka market in Janury 1973, under the brandname 'Tea-ko' with a full page advertisement in the Ceylon Daily News.

However there were hardly any sales and no royalty in terms of the agreement was forthcoming to the CISIR. In fact by November the same year production was at a standstill and the CISIR wrote to the firm that no progress at all had been made and suggested termination of the agreement. The firm informed CISIR that the hold up in production was due to non-availability of suitable crown corks and problems with the pasturizing equipment. Ultimately in January 1974 the agreement was terminated.

T-Co of the Ceylon Brewery Ltd.,

Negotiations with the best known brewery in the country to undertake the manufacture of the carbonated tea drink according to the CISIR process commenced in August 1974 and the agreement was entered into four months later. The brewery was to market this drink under the brand name 'T-Co'.

Around this time the economy of the country was at a low ebb. Raw material imports were permitted only on licences issued by the Ministry of Industries and Scientific Affairs and import allocations were subject to considerable cuts. Besides, sugar an important ingredient in the manufacture of T-Co was in short supply and world prices reached levels never heard of before. In Sri Lanka industrial requirements of sugar had to be obtained on permits issued by the Food Commissioner at two and a half times its normal price. This situation had its repercussions on the new venture too, where production was delayed and requests made to the CISIR in January 1975 for sugar and in March 1975 for Sodium Alginate. By December 1975 although the situation in the country had improved sales continued to be poor. The Brewery promoted T-Co in the same manner as their own beers, through Tourists Hotels and liquor shops. As a result the sales of the drink amounted to only about 400 gallons in each of the years 1973 and 1974. As these figures show sales were never on a large scale.

Almost mercifully, the manufacture of this carbonated tea drink at the brewery was stopped on the orders of the government Excise Department which ruled that equipment used for beer manufacture should not be used for processing other materials as they were likely to contaminate the flavour of the beer.

Analysis of the Failure to Make a Successful Commercial Venture of the Process to Manufacture a Carbonated Tea Drink -

We have made a careful study of the reasons for the failure to make a commercial success of the process to manufacture a carbonated tea beverage. In fact it formed a subject of study for a Workshop on Marketing for R and D personnel held in Colombo during October 1978. I shall try to be frank and as objective as possible in presenting this analysis so that a fruitful discussion can follow from which all of us participating in this workshop can benefit

The product made under laboratory conditions was evaluated by professional tea tasters in commercial tea marketing firm and pronounced good. The products of some of the trials carried out were good, others were scarcely palatable. I remember the uncomplimentary remarks made by some of the visitors to the CISIR Exhibition of 1976 where the carbonated tea was sold. On the other hand there were customers complaining of wanting to buy this product as it was much appreciated by their guests, but being unable to buy it. One such person was the Cultural Attache of the French Embassy in Colombo. It was clear that factory process control was inadequate. Inadequate supplies and lack of adequate quality control measures were howerver only a small part of the story.

More fundamental reasons were adduced at the marketing workshop which were not available at the time to CISIR staff members. The soft drinks market is an extremely competitive one of the world over and breaking into it is no easy task. An aggressive and expensive sales promotion campaign is one of the pre-requisites for doing so. The soft drinks market in Sri Lanka is dominated by two firms. One of them holds the Coca Cola franchise and cannot be expected to market a competing product. The other, an old established firm, has been marketing their own brands of soft drinks which are popular throughout the country. They not only have an established name but also advertise their products widely. This company had no soft drink product in the Cola

line of drinks or any substitute either so that when they learnt of the CISIR product they showed interest and made enquiries about the p. .ibility of their manufacturing and marketing. Here then, unknown to the CISIR scientists, was their best chance, perhaps the only chance for successful commercial exploitation of their process for manufacture of a carbonated tea beverage. The project leader was suspicious of the intentions of the company's manager in asking the questions he did. He feared that the company would use the basic information we provided on our process to develop their own technology. His response to the overtures of the company was cool. Rebuffed, the company proceeded on the development of their own version of a soft drink to compete with Coca Cola. One significant feature was that they mounted a vigorous advertising campaign to promote this product, which is now establihsed on the market. The CISIR carbonated tea beverage in our opinion was, as good as this product.

The means adopted by CISIR to sell its technology namely advertising in the classified columns of a daily newspaper would appear amusing today. It read as follows :-

Business Opportunities

Financiers required to promote the manufacture of new Carbonated Tea-based Soft-Drink Beverages. Laboratory Tested Formulas, Patent Pending - Apply P5662 C/o Daily News.

The first company that was licensed to use the CISIR process was a subsidiary of the country's largest biscuit manufacturer. Their venture into aerated water manufacturing was not a success. Apart from the problems of breaking into a market dominated by two well establihsed firms the economic environment did not favour manfac rers of such products like confectionery, biscuits or soft drinks which were classified as non-essential by the government authorities of the day. These difficulties were compounded by internal management problems of the company.

The brewery was selected as the second licensee because beer was also a bottled drink and the bottling and other equipment was being utilised only during part of the time owing to restrictions on the import of raw materials. Here again no sustained or worthwhile effort was made to establish this new product, the carbonated tea beverage named T-Co. Beer was the Company's money earner and rightly received most of the managements attention. As already mentioned the quality of the T-Co varied and supplies were received only sporadically by dealiers. The reason was that T-Co was made only when the equipment was not needed for making beer. The end was predictable.

The Institute itself had several lessons to learn from this failure to successfully commercialise the process for the manufacture of carbonated tea beverage from green tea leaf. I sahll try to enumerate them.

1. In experimenting with a material that is as variable as green tea leaf a statistically determined number of trials (in line with the number of variable) must be carried out both at laboratory and pilot plant levels.

2. Market studies must be carried out at all stages of development.

3. The choice of the correct industrial partner is of paramount importance to the success of the project. Good publicity must be given to the product. The organisation that can make a success of utilising the technology should be given every encouragement to commercialise it.

4. The utiliser of the technology should ensure uniform quality of all batches of the product and regular supplies of it to distributors.

5. New products need to be introduced to the market by appropriate advertising.

How unaware we were then of the real problems involved in the commercialisation of the technology we had developed for the manufacture of carbonated tea can be seen from the fact that we had patented this process in no less than 22 countries stretching from Canada to New Zealand, needless to say at considerable expense. A country which is one of the largest buyers of our tea in the Middle East officially "offered to gradually change over from bulk teas to bottled teas if and when the product is ready for the market". Such were the hopes we generated for our carbonated tea.

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.435/8
16 January 1985

ENGLISH

Regional UNIDO/ESCAP Workshop and
National Consultations on the
Commercialization of Research
Results

Bangkok, Thailand, 15-19 October 1984

COMMERCIALIZATION OF RESEARCH RESULTS OF SRI LANKA*

by

A.N.S. Kulasinghe**

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** National Engineering Research and Development Centre, Colombo, Sri Lanka.

V.85-20901

General

Commercializing of research results is generally a more difficult task than the marketing of the products resulting from the research. In general, factors which influence marketing of the product more or less will decide whether the research results should be commercialized. In many instances where there is a favourable market for the products coming out of the research results, it might happen that the development stage of the project falls short of the industries expectation, specially when the industry is ill - equipped to complete development work. In a business climate where interest rates are high and economic planning is de-emphasized, industrialists tend to concentrate on quick yielding projects and shy away from introducing new products. This situation is further aggreviated in most developing countries where the economic planners are insulated from the pressures of the business environment and are insensitive to the risks involved in launching new products. They fail to appreciate that in most cases where the products are commercially successful, benefits accruing to the consumer out-weighs the benefits to the innovator, a fact well documented by Mansfield.

Whether the research result in a process or a product, and whether it falls into the consumer domain or the industrial domain, will determine the strategy to be adopted in the commercialization phase. It is not possible to say that a particular strategy is correct or incorrect. We can say that the strategy in general is successful or unsuccessful. The strategy an organization will adopt is also influenced by its own capabilities and outlook. The organization may opt for a mode of commercialization minimising its involvement and effecting earliest transfer of technology. Another organization may well try to maximise benefits from the new technology so as to ensure the greater good of the greater number. Where the technology enables the satisfaction of a basic need being denied to the majority-due to the high costs of the product or service,available with the technology in current usage-the consumers' low purchasing power and their high expectations are often major obstacles to successful commercialization.

In such a situation profit margins tend to be low while the marketing costs tend to be high. Therefore established businesses will usually avoid such projects. The established businesses prefer to service either industrial customers or the high income group rather than to service the masses having low disposable incomes. If you live in a country like Sri Lanka with a per capita income of only $300 per annum, opportunities available for such highly profitable quick yielding projects are very limited, especially considering the population's obsession for imported goods liberaly available in an "Open Economy". No wonder then that most businessmen prefer to engage in trade rather than engage in manufacture and there is an acute lack of bankable projects according to local development banks. The trend in modern technology development is for mass production and automation. With the existing low level of technical capability within the country, and the small size of the market, local manufacturers find it impossible to reach economics of scale achieved by the foreign giants. Even a 50% tarriff protection is quite often insufficient to protect such local industries.

Link Mechanisms between Research and Industry

Most manufacturing industries in developing countries like Sri Lanka have to fight hard to maintain their status-quo. Their planning horizon does not extend more than one year and in many cases it covers only one month ahead. In the face of falling demand due to inevitable changes in the product life cycle and their inability to introduce viable new products consistant with their manufacturing capabilities, most manufacturers turn to trading activity as an alternative to manufacturing. In countries like Sri Lanka where special priviledges are accorded to foreign joint ventures, local businessmen would jump at a foreign proposal, whereas a similar proposal from a local party would be held in disdain. This unhealthy situation is not because of a lack of linkages between industry and research institutions but more due to differences in their objectives and outlooks.

It is the avowed objective of industry to make profits. As almost all the research institutions in developing countries like Sri Lanka are public sector institutions their objectives are seldom profit oriented. They are supposed to further the national development in the long term and to solve technical problems of the state sector and of the less priviledged business organizations. This is based on the idea that large established businesses should not be provided subsidised services by state research institutions since they should be in a position to undertake such activity by themselves. Developed countries like Japan and U.K.,in general,favour basic research to be done by state institutions and the more directed and industry specific research to be done by research institutions sponsored by trade associations. It is unfortunate that business entities in most developing countries like Sri Lanka where small market size results in severe local competition, hesitate to co-operate together to improve their lot. On rare occasions where trade associations do exist their activities are restricted to such administrative matters as import quotas and tarrifs and to common marketing programmes such as exhibitions. If their members come across research results that would help raise the level of industries performance such results are rarely passed on to the association to be circulated to the membership. In 1976 the NERD centre in association with the Industrial Development Board of Sri Lanka was instrumental in forming the Foundry Association of Sri Lanka. During this period import of foreign machinery was restricted and the local foundaries had plenty of work. The question of import quotas and duties for imported foundry coke dominated much of the business meetings of the association. After surveying the different products made by members of the association a project was started to improve the quality of the locally manufactured sugar cane crushers since there was a heavy demand for such a crusher due to the prevailing high prices for sugar cane jaggery. The NERD centre in colloboration with the Foundry Association organized a number of seminars for improving current foundry practices and to establish better manufacturer-customer rapport. Unfortunately by 1978 the sugar cane jaggery market crumbled and local sugar cane crusher manufacturing completely ceased with the liberalized import of foreign crusher machinery. Today the Foundary Association has ceased to exist and only a few of the foundaries are still in operation.

Consultancy is a common and import link between research institutions and industry. In small developing countries like Sri Lanka the few existing research institutions have to spread their resources over a very wide field, and as such lack the depth and expertise a particular industry may require for a specific job. Further,unless the matter is extremely urgent the industrialists prefer to call consultants from abroad usually from one of their associated companies or from their equipment suppliers. With the high incidence of foreign joint ventures the number of foreign consultants in the country is very large and involves a large commitment of funds, a large proportion of which is paid out in foreign exchange. Industry and the government has so far failed to appreciate that the building up of a cadre of local consultants is essential to local technology development. Not only will the country save enormous sums in foreign exchange paid to foreign consultants but also the gains from the "learning by doing" process will benefit future projects. A special handicap faced by public institutions engaged in consultancy work is that the customer is reluctant to pay for such services expecting them to be provided free by the public sector institutions as a service from the government. This is a major draw-back in trying to improve the quality of locally produced goods since it is difficult to convince the budding industrialist that he needs technical assistance in addition to which he has to find the money to pay for it. In spite of its draw-backs the links resulting from consultancy work are important to appriase industry of the work of the research institutions, and serve as a source of feed back information both in initiating new research projects and in setting priorities for existing projects.

Some research institutions are in a favoured position in that they perform certain services to fulfill statutory requirements like quality control certification etc. Contracts so established will gradually lead to fruitful co-operation in the future. Sponsored research is another important link mechanism existing between the research institutions and industry. The usual arrangement is for industry to fully or partly finance a particular research project conducted by the research institution. Depending on the covering agreement the research results would be made available only to the sponsoring partly or held confidential for a limited period and in other cases are made available to the public on the payment of a fee.

Sponsorship of research could well be in the reverse direction where part or the whole research work will be conducted by the industrial collaborator. Between 1975 and 1977 the NERD CENTRE also operated such a scheme of awarding research contracts to individuals or industrial institutions. The cost was met fully or partly by the NERD Centre which retained control of the use of the research results on an exclusive or a non exclusive basis depending on the circumstances. In 1972 when NERD Centre moved to its present premises and were able to acquire the necessary facilities contracting out research work was curtailed and undertaking sponsored research was started. Because of the limited financial resources of local industries, much of the sponsored research undertaken so far has been at the request of the state sector organization like the Ministry of Fisheries, Mahaweli Authority etc.

Publications, Seminars and exhibitions are another important set of link mechanisms. The Centres resources do not permit the opportunity for a regular publication but the staff have contributed articles to scientific journals and newspapers. The Centre has been instrumental in organizing a number of Seminars both at the national and international level. It has also participated in a number of Exhibitions held in different parts of the country and abroad. This set of link mechanisms provide for the transfer of information right down to the grass root levels and therefore are very important both to the institution and to the country.

Since much of the commercializing activity of an institution hinges on mobilizing the interest of prospective entrepreneurs, collaboration with ongoing entrepreneur developed and business development programmes is vital. In Sri Lanka we are happy to have been associated with the entrepreneur development programme organized by the National Chamber of Small Industries and we have established in-formal links with other programmes such as the entrepreneur certificate programme of the Open University, work of the Business Development Centre and the Entrepreneur Development programme of the Industrial Development Board.

For projects that are suitable for commercializing on a distributed manufacturing basis, the level of success of current licence holders will greatly influence the number of future applications. In such instances the extent of the franchise type of services provided by the licenser and the build up of the demand for the product needs to be supplemented with guidance in business development and assistance in product promotion, specially on the national level. They say "Nothing suceeds like success" and in developing countries like Sri Lanka, it often happens there is spate of mushroom imitation manufacturers producing inferior quality products and under-cutting on price to the detriment of everybody. Unless patent protection is available, controlling the situation is very difficult and requires extensive field work and customer education.

Common bottle-necks to commercializing research results

Many developing countries have fallen into the trap of establishing research institutions without adequate provision of means for commercializing research results. The developed country model of a research institution passing on the results at the prototype stage for industry to continue the development and to set up production facilities,does not work in a developing country lacking industrial ability to do its own development, design and engineering for production. Even in the instance when the research institution is able to assist in all these stages upto planning production facilities, industrialists in developing countries often hesitate to commit funds and facilities to build up markets and absorb the likely initial losses since they operate on a short planning horizon as discussed earlier. Although complexity of the product and nature of the market for the product etc.will determine the actual cost for the different stages up to commercial introduction of the product, a rough estimate would be that development cost will be about 2-5 times research costs while the cost for setting up production will be 10-100 times the research costs. This large variation accounts for the possi- bility of the manufacturer using sub-contractors as opposed to large scale manufacture using certain amount of automatic machine systems. If the commercializing strategy calls for fast market penetration (so as to maximise benefits from patent/licence conditions that are time limited) commercial launch has to be accompanied with substantial investment in product promotion.

It is not unusual to devote about 15% of planned turn-over in the first few years for product promotion, this allocation being reduced to a level of about 7 1/2% on turn-over by the 5th year. The problem is further aggrevated in developing countries like Sri Lanka by the attitude of even the development banks which are quite adverse to lending money for innovative products since they do not have the facility to appraise technical and commercial feasibility of new products and processes. Not only is there a requirement for large amounts of funds to bridge the gulf between research results (prototype) and commercial success of a project but there are definite time spans for the respective stages of the project upto market success. In a situation where the cost of capital is very high, 'time is money', which further aggrevates the dilemma of project financing. Glib promotion by interested foreign parties and popular though somewhat wishful talk of "Leap frogging" developement processes, makes the public and the decision makers impatient with the commercialization process in real life. Even in developed countries major projects like nucleur power stations have a gestation period of about 10 years while a much simple project will have a gestation period of about 1 year. In the circumstances even a fairly simple project in a developing country can be safely assumed to take up to 2 years to reach commercial use. Where the project involves a complete re-design to be consistent with the factor endowments of the country a period of 3-5 years can be considered satisfactory except for very simple products where readily available materials & production processes can be applied.

For successful commercializing work sound technical background is very necessary together with a well developed business acumen. In addition there is a need for an abundant supply of optimism and endurance to be able to overcome bureaucratic red-tape, materials and machinery shortages, lack of skilled man-power, high inflation rates, etc. which are the common denomination in almost all developing countries.

A further problem faced by developing country persons engaged in commercializing research results stems from the inordinately high expectations of the local populaltion who wants the local products to be equal or better(sophisticated)than the imported products while at the same

time to be cheaper than the imported products. People who can only afford a bicycle costing Rs. 1500/- will yearn for a motor cycle costing Rs.15,000/- and not purchase the available and affordable bicycle. Most consumers in developing countries using the imported products as a yardstick in evaluating local products would look down on a locally manufactured television set if it had only two chanrel selectors whereas the imported product has (say) 12 channel selectors, being quite oblivious to the fact that in Sri Lanka there are only 2 broadcasting channels in operation.

What I have said so far may give you the impression that the R&D research institutions and those carrying out commercial activity have no shortcomings and that all the causes of our failures to achieve commercial success lie outside. This is not so and if we technologiests meeting here today continue to pat ourselves on the back and blame everybody else, we would only be fooling ourselves. Only by critically reviewing our performance can we look forward to improvement in the future.

One of the major failings the techonologists are prone to, is to be carried away with the technical excellence of the technological product or process, and not to be attuned to the commercial realities. On one extreme is the hurry to introduce a product to the market without sufficient attention being paid to prototype evaluation, field testing under actual user conditions, ironing out production problems or not building up adequate customer acceptance. The other extreme could be that the technologists who strive to make the perfect product from a sense of high technological achievement, quite forgetting that such a product cannot be sold because the cost will be excessive. This is aptly put in the saying "the better is the enemy of the good", meaning a product may be sufficiently well developed to be acceptable to the market at a given price and time, whereas further development of the product might mean the loss of the market due to either the product getting priced out of the market or a competing product capturing the existing market. This need for timing, pricing and building up customer acceptance no doubt have been bitter lessons to many of us in building up our business acumen.

Another major cause of failure at the commercializing stage is the shortcomings at the research project formulation stage. Common practice in a well planned industrial organization is for new product ideas to be evaluated on the basis of a thorough technical and market assessment. Close colloboration between marketing and the technical personnel is essential for producing commercially successful products. Since most research institutions in small size developing countries like Sri Lanka are constituted to work on specific stages of the research/development/ commercializing process they tend to cover a wide variety of subjects but not through all the stages of the commercializing process. This is the result of adhoc planning and over dependence on foreign consultants/aid donars who tend to favour the establishment of new institutions as a monument to their services. In Sri Lanka we have a number of research institutions and universities engaged in laboratory research work covering specific sectors, most of them in the field of agriculture. On the industrial side we have the Ceylon Institute of Scientific and Industrial Research which is represented by my colleague Mr. Mervyn Wijeratne, the National Engineering Research and Development Centre of Sri Lanka concentrating on all engineering aspects of project development and the Industrial Development Board concentrating on industrial extension. We also have 2 local development banks which are supposed to provide funds for development projects but in practice are no better than the other commercial banks when it comes to financing innovative projects and grass roots self employment programmes. Particular aspects of the situation are: the suspicious nature of most technologists who are afraid that their research results will be stolen by others; the "not our baby syndrome" meaning that projects originating from outside an organization are given only step motherly treatment; and the inevitable clash of personalities/identities of individual technologists/institutions. This problem has been well studied and there is now sufficient evidence to show that the "Product Champion", who champions the project when it passes through the different departments of the organization at different stages of the development process, is vital for the commercial success of the new product. I am sure many of you have been confronted with the situation of having a nice product for which there is no ready market. If market research and market development was planned to be in phase with the

technical development of the product, by the time production is ready to start, the market would also would be ready to absorb the product.

Case Study of the Prashakthi Project

Before I proceed to talk of national technology policies and regional collaborative action, I wish to take the opportunity to present a case study of one of our projects called "PRASHAKTHI'. I will confine myself to only one study, since it will be more illuminating to go into it in some depth so as to enable specific conclusions to be drawn rather than to cover many projects very briefly.

This project was selected for presentation not with an idea of boasting about our success but as we consider it to be an unique approach to solve a problem common to most of the developing countries in the region. On the other hand you might have been bored if I were to recount some of our failures since as I have already mentioned, much of the causes of our failures would be common knowledge to all of you.

PRASHAKTHI is actually a trade mark we had registered for a DC operated Fluorescent light using an electronic inverter circuit. The project was started in 1981. Initial work in modifying available electronic circuits to produce a satisfactory prototype required about 2 months. This was further developed to enable local manufacture by local technicians using locally available materials so as to satisfy the minimum functional requirements of a rural cottage. Minimising sales price was paramount. The basic system comprises of a 12 volt battery having a capacity of 45 amphrs. from which one or two small fluorescent lights are operated. The cost for such a set is approx. 25 US$ with only one light unit or US$ 30 with 2 light units. It is not my intention to go into the details of the technology assessment and the market assessment which resulted in the present specifications for the light units and the battery. I will rather elaborate on the commercializing aspects of the project. If any of you are interested in obtaining more information of the above mentioned aspects I have with me a few copies of a report by Mr. A.L.M. Perera Head

of our Techno Economics Section giving relevant details. At the start of commercializing this project, we had the following options -

a. to give wide publicity to the proposed lighting system and to make available designs to interested parties on a free of charge basis;
b. to transfer the research results to a large company on an exclusive basis;
c. to transfer technology to a limited number of manufacturers on an area basis.

Option (a) was dicarded since we had adopted similar approaches on two previous occassions when trying to popularise wind mills and solar water heaters, with disastrous results. From the response to the few inquiries made from established industrialists it was clear that they were not interested. They considered the special effort to build up a rural market, when the income level is very low, would not be profitable for them. When we advertised in the newspapers for prospective manufacturers, the response we had convinced us that option (c) was the most suitable for the project.

We had replies from about 50 prospective manufacturers from different parts of the country. From these applicants we finally selected 11 parties to whom the manufacturing technology and the right to use registered trade mark "PRASHAKTHI" was conferred, at a technology transfer seminar held in August 1981.

Some of the main provisions in the technology transfer agreement entered into on this occassion were as follows:-

a) We the licenser will provide complete technical information, training and continued technical assistance for the duration of the agreement period of 5 years, in all matters connected with the manufacture of Prashakthi light units.

b) The licenser will allow the use of the trade mark for the period of the agreement and thereafter if the agreement is not abrogated before the expiry of the agreement period.

c) The licensee will undertake to maintain confidential, information specific to the technology transfer, and to return all written/printed materials should the agreement be abrogated before its expiry date.

d) The licenser will provide full information on all future developments in connection with the Prashakthi lighting system.

e) The licensee should maintain recommended quality standards and give an year's guarantee on the products sold.

f) The licensee should pay an initial license fee and a royalty fee on sales for the duration of the agreement on account of the supply of technology and the facility to use the registered trade mark.

g) The licensee will take adequate steps to build up a minimum stipulated market for the products within 2 years of commencement of production.

The agreement also provided for the licenser to abrogate the agreement should the licensee -

a) willfully fail to maintain confidentiality of technological information received

b) if the licensee fails to pay the royalty dues according to the agreement

c) the licensee does not make adequate effort to build up the minimum stipulated market in the region allocated.

The criteria used to assess the suitability of the applicants can be briefly summarised as follows :-

a) application should live within the region for which application is made

b) he should possess a minimum capital of Rs. 10,000/- (approx. 400 US$) or proportionaltely less if he already possess some of the facilities required

c) either he should have had a secondary education in science or have had followed an electronics training course or have had experience in electronics or radio repair work

d) he should have a firm desire to set up his own business and be appreciative of the necessity to work hard to achieve success.

In the first instance all the applicants were sent a questionnarie to be filled and returned on the basis of which a selected number were invited for an interview. Those selected from the interview and who were agreeable to the terms stipulated in the technology transfer agreement, were finally selected. Following the 1981 technology transfer seminar, we have had 2 more technology transfer seminars the number of licensees appointed growing each time. We now have issued 62 licenses so far. Almost all major population areas have been covered accept in the north and eastern provinces where language problems have so far restricted our activities. Within the next year we hope to increase the number of licensees to about 120 thus adequately covering the full island. Seeing the extent of the success of some of our licensees many other imitation manufacturers have started up production. While we do not permit our licensees to sell in another licensees areas, we have no control over the imitation manufacturers. Most of them produce low quality products and sell at low prices, resulting in disrepute even for the Prashakthi light units. Quite a number of these manufacturers have applied to us for a license and have had to be turned down,since we already have a licensed manufacturer for the particular area.

Since the vast majority of the rural population used kerosene oil for domestic lighting,the government has been compelled to subsidise the price of kerosene as well as to provide limited quantity of kerosene as a free issue to about 1.5 million house-holds living on or below the subsistence level. Since the introduction of Prashakthi would allow the government to

save on the recurring subsidies and would help reduce the country's foreign exchange out lay on imported kerosene (approx. 80 million dollars per annum), we were able to obtain funds for a limited amount of product publicity on the national level. We were also able to obtain certain amount of funds to establish a revolving fund which we used to stock quality components required by our licensed manufacturers. We were thus able to ensure the continuity of supply of quality components and pass on to the small scale manufacturers also the economies of bulk purchasing. We have obtained certain components like transistors, fluorescent bulbs, etc. from highly competitive foreign sources while other items like plastic tube holders, etc. have been farmed out to local manufacturers, effecting considerable cost savings and providing opportunities for further local employment.

Regularly contact has been maintained with the licensed manufacturers who are provided guidance in the development of their business, in the improvement of their production facilities, on the scope and methodology of local product promotion and also assistance in preparing applications for bank loans/over drafts.

We have used the Prashakthi project as a launching pad to start off too more programmes :-

a) to locally manufacture battery chargers
b) to help establish battery charging centres

Both of these would generate self employment, further reinforce the popularization of Prashakthi and help to cut down foreign exchange expenditure by import substitution. To date we have issued about 25 licenses to manufacture battery chargers and we have registered about 100 battery charging centres which numbers are being continuously extended. Except for a few cases of licensees who obtained the license but did not actually start-up production and a few other loses when the licencee moved out of the area allocated to him, the number of business failures have been small (about 15%) even by international standards. While most of our licensees started as part-time manufacturers, many of them have now made it their full time business.

I would now like to draw some inferrances from this novel experience in commercialising research results. The first inference I like to draw is that mass markets for intermediate technological products do exist even in some small size developing countries like Sri Lanka and they can well be serviced by a network of rural manufacturers without the need for large scale automated production facilities for which foreign intervention would have been necessary. Although the existing product (kerosene oil lamp) which Preshakthi aims to replace is enjoying substantial government subsidies yet attempts to transfer the subsidies to a once and for all part payment against the purchase of Prashakthi cannot readily be implemented due to the inertia of the bureaucracy and consumer reservations to any changes in the government subsidy schemes. We also had to face hostility from other state sector organizations who felt we were intruding on their terriority whereas they should have been thankful that as a result of the success of our project, political pressures to undertake uneconomic programmes would be releived. The continued guidance in business development has enabled the growth of a number of viable techno enterprises in rural areas, many of whom have now effected further improvements in the product. Since we have still not got the full complement of licensees we have had to extend our business development services somewhat longer than earlier anticipated. We have found that the provision of such services has enabled us to ensure that royalties are paid regularly since there is a common tendency to evade such commitments specially among small industrialists in developing countries.

We feel that the project has been a commercial success in that we have received royalties amounting to more than 10 times what we had spent on research and development. Looking at the social benefits from the project which far out weigh the financial benefits, we are indeed sorry that we have not been able to further expedite the market penetration. On a rough estimate the social benefits would be more than 10 times the expenditure on market promotion. A proposal we have made to the economic planners for transferring the present kerosence subsidy is held-up, as some of them are still not convinced that the project is a success, while others seem to be of the opinion that if the project is a success there is no need for government assistance.

National Technology Policy with regard to Commercialising Research Results

Following from the excellent work done by UNIDO, UNCTAD, the need for technological self reliance in developing countries has now been accepted by most people. Unfortunately, proponents of the "Open Economy" system have confused the issue by mistakenly linking technological self reliance with technological isolation. To avoid such confussion I would prefer to use the term technological sovereignity. A study, carried out a few years ago by the Science Council of Canada, concluded that Canada - a major developed country - seemed to lack sovereignity over its technological development process. If it is so with Canada, how much worse will it be for small developing countries in Asia. At the early stages of technological sovereignity the stress would not be on the technological and scientific capacities but on the decision making autonomy for defining technology requirements, followed by acquisition and absorbtion. A somewhat more developed developing country might focus attention on the autonomous capacity for producing goods and services considered essential in its development strategy. Whatever the strategy and focus, to have control over technology is paramount since technology is one of the prime movers in the process of development. Technology can be said to consist of knowledge, skills experience and organization that is required to produce, utilize and control goods and services. The reknowned economist J.K. Galbrailh tracing the shift of power among the different factors of production, starts with the importance of land in the feudal times where property entailment ensured control in land ownership. With the start of the Industrial Revolution and the opening up of the New Worlds, Capital became the controlling factor. Next comes the entreprenour, whose fore-sight and ability were necessary to put together the different factors to form profitable ventures. Today he has been superceded by the large corporation since planning and organization required by modern technology is beyond the capacity of any single person. This entity,which embraces all who bring specialized knowledge, talent or experience to group decision - making within the large corporation, he called the Techno-Structure. Developing countries also like the major corporations (whose turnover could well be more than the GNP of many small developing countries) needs this techno structure if they are to benefit from todays technology.

It is no doubt futile to promote technological sovereighnity without recourse to planning and the preparation of policies which are linked to strategies of national development. Technology planning implies the existence of a formally constituted and internally consistant set of goals, objectives and instruments. For the majority of developing countries, the need to develop a technology planning capability is becoming increasingly urgent but experience has so far been dissapointing. Without technology planning a country will find it difficult to decide where the technological inputs need national development efforts, what items sought to be imported and what should be obtained from domestic sources. Also it will not be possible to ensure that the technological inputs are appropriate from the view-points of resource use, employment creation, income redistribution, needs satisfaction and environmental effects. In general, systematic progress towards the strengthening of endogenous capabilities and the substitution of appropriate domestic technologies for imported ones will be impossible without the existance of a broadly planned frame-work over a long period within which individual development projects can be fitted. Only very few of the developing countries can be said to have a technological intelligence, i.e, the capacity to appropriate and utilize knowledge. Technological intelligence is an essential component of and anticipatory intelligence, or the capacity of a nation to identity it's relevant strengths and weakness, to understand and analyse threats and opportunities of different kinds and to translate the resulting knowledge into policy and action.

In Sri Lanka where even national economic planning has been relegated to a rolling 5 years public sector investment plan with only a hazy expectation of the private sector investment component, technology planning up to now has been at a minimum. The government seems to have realized the gravity of the situation and steps have been taken to appoint a committee to go into this matter.

Some of the other features a National Technology Policy should take into consideration are :-

- invention promotion
- influencing technology demand

- converging needs with effective demand
- special fiscal and monetary incentives for innovative enterprises
- special provisions to ensure local technologists are given preference in technology contracts and that where foreign contractors are necessary that it should be mandatory that they work in collaboration with a local company/consultant
- promotion of a local technology consultancy capability
- promotion of self employment and techno-entrepreneurs
- policies of government purchases to reflect social benefits from distributed small scale manufacture and the upgrading of traditional technologies
- levy of a tax on imported technology products and services and utilising proceeds to promote local technology development and diffusion.

Regional Co-operation in Relation to the Innovative Functions

Stimulation of the creation and adaption of appropriate technologies presupposes selectivity in the international co-operation to support indigenous capacities for innovation. Thus developing countries should seek controlled co-operation rather than passive, economically channelled integration among themselves.

The distinction between co-operation and integration has to be made. The latter is a result of the uncontrolled workings of economic - primarily private - forces, with factor mobility across national borders. The former indicates a political attempt to guide and control the relations between the participating countries. Since the aim of the co-operation is to strengthen indigenous capacities for innovation through intensifying economic relations among the participating countries a co-operative scheme may easily turn into fostering integration in accordance with the interests of either the strongest of the participating states, or the strongest group of private business enterprises notably transnational corporations.

Therefore national industry and technical planning on a sectional basis should be the first pre-requisite for effective co-operation. The indigenous innovation capacity is necessary to enable a conscious continuous evaluation of the ways in which a country may acquire different types of technology and other inputs in the national innovation processes - through national investments, through importation from industrialised countries, through joint ventures with foreign enterprises, through co-operation among developing countries, or through a combination of these ways. The first step is to establish sectoral priorities for the technological transformation, based on the specific sectorial linkages in the country. Secondly an evaluation has to be made of gaps between actual and required capacities (technical, financial, institutional and social) for innovation in the selected sectors. The third planning step is to determine whether innovations can be attained through improvements in the indigenous capacity in other sectors or at other levels of society. Finally, bilateral or multilateral co-operation should be established in areas where the required capacity improvements cannot be obtained solely through national activities.

The appropriateness of possible partners for regional co-operation should be carefully scrutinized. It is not enough to belong to the same geographical region or sub region. The potential area and the contents of the co-operation should decisively influence the selection of partners. A genuine common interest should be at hand. Where similarities exist in identified needs/ problems and/or where there is a similarity in the available factor proportions or in the factors, a joint programme may be called for. Where complimentaries exist, a shared programme where each participant undertakes their part where he is most proficient in, so that the nett result would be to the mutual benefit of both,is the most appropriate. Technical co-operation between developing countries must be taken in the context of an overall economic co-operation programme. Where the flows of technical goods and services is predominantly in one direction, the recepient should be provided adequate avenues by appropriate barter provisions so as not to aggrevate foreign exchange difficulties and the ultimate ability to continue such purchases.

Where the differences are so big and one sided that they may lead to foreign dependence rather than mutual inter dependence, programmes like TCDC and ECDC might well be like 'going from the frying pan into the fire'.

Some possible areas where joint action may be desirable among suitable parters would be as follows:-

a) Joint programmes covering research and experimental development or engineering
b) Information and intelligence net works including research seminars, and political consultation
c) Joint training schemes
d) Exchange of know how and consultancy services including engineering, and management
e) Licensing, consultancy and other fields of techno economic co-operation
f) Research into the special nature and problems involved in innovation in developing countries
g) Collaborative effort to foster an awareness and build-up of the local expertise to carry-out technological planning

Conclusion

To conclude I would like to stress that technology could and should be the prime motive force of development rather than a passive follower. Neither technology nor the needs and problems of the developing countries remain constant. In many of our countries much work remains to be done on Technology Planning. This I think should be priority one both in terms of national action and from the point of view of regional and international support. Once national concensus - on where we want to go and what we want to do - is achieved much of the present problems encountered in commercialising research results will get resolved.

United Nations Industrial Development Organization

Distr.
LIMITED
ID/WG.435/9
16 January 1985
ENGLISH

Regional UNIDO/ESCAP Workshop and
National Consultations on the
Commercialization of Research
Results

Bangkok, Thailand, 15-19 October 1984

COMMERCIALIZATION OF RESEARCH RESULTS IN MALAYSIA - A NATIONAL PERSPECTIVE*

Prepared by**

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** Standards and Industrial Research Institute of Malaysia and Ministry of Science, Technology and Environment, Malaysia.

V.85-20902

1. INTRODUCTION

The main objective of this paper is to outline the status of the commercialization of research results by research organizations in Malaysia in general, and in particular, to highlight the perspective developments of the Standards and Industrial Research Institute of Malaysia (SIRIM) as a pioneer institute supporting industrial development through R & D*. Commercialization of technology is meant to cover the means, methods or systems applied by an organization to market or transfer in a commercially viable manner, technologies indigenously developed by it or acquired and adapted from outside sources, for utilization by the local industrial sector.

2. THE DEVELOPMENT OF R & D INSTITUTIONS IN MALAYSIA - TRENDS

Historically R & D institutions in Malaysia were established on the basis of the then existing socio-economic development trends of the country. Most of the major R & D institutions in the country are either government funded or funded by collection of cess from the targetted industries that the R & D institutes are set up to serve.

The first industry-oriented R & D institute to be established was the Rubber Research Institute of Malaysia (RRIM) in 1925, to support rubber cultivation practices in the country. Its research is financed by a cess collected on every ton of rubber produced,

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* Research and Development

and research projects are concentrated on all aspects of rubber cultivation, latex production, development of new forms of rubber and consumption trends, as well as technological and end-use research in the processing and manufacture of natural rubber products.

In 1929 the Forest Research Institute (FRI) was established to support the timber industry with R & D, on planning for forest conservation, utilization schemes, feasibility studies on reforestation schemes, research into industrializing of large scale forestry-based industries and farming new species of trees that will contribute to a continuous supply of raw materials.

The two research institutes above were tailored to assist the development of the specific industries as rubber and timber were two of the three (tin being the third) major revenue earners for the country prior to the 1960's.

In 1970's the government adopted the economic strategy to diversify its activities into the cultivation of other crops. This led to the establishment of the Malaysian Agricultural Research and Development Institute (MARDI) in 1969. This institute conducts research into other agricultural crops apart from rubber. In the late 1970's palm oil became prominent as a major revenue earner for the country and in 1979 the Palm Oil Research Institute of Malaysia (PORIM) was established. Research on palm oil was initially conducted in MARDI prior to 1979 but in view of the increasing acreage of oil palm being cultivated(in 1980 about 1.04 million

hectars) it was thought that the thrust given to this crop and its products by a branch of MARDI which is also dealing with other crops, would not be equally effective. This institute's activities are financed by cess, and research projects include those on oil palm cultivation, breeding through selection, agronomic studies and end-use research.

In the late sixties and the seventies there was a concentration of efforts by the government to boost industrialization and to give priority to import substitution industry and agro-based industry. In 1969 the Standards Institution of Malaysia (SIM) was established and was closely followed in 1971 by the National Institute for Scientific and Industrial Research (NISIR). The aims of both institutes were to promote and foster product development and downstream development of resource-based industry thus enhancing government's efforts to encourage industrialization.

In 1975 SIM and NISIR merged to form the national industrial research institute called the Standards and Industrial Research Institute of Malaysia (SIRIM). The main objectives of this institute are to provide scientific and technological support to the industrial development of the country. Its activities include technology transfer, extending industrial consultancy to the industry and providing technical assistance through scientific and technical testing, training of technical manpower, certification of products, standardization activities and industrial research.

3. THE STATE-OF-THE-ART OF COMMERCIALIZATION OF RESEARCH RESULTS

Malaysia's prime concern in the pre take-off period to industrialization was in the development of its primary resources in the areas of improving quality and yield of the primary products rather than development of downstream processing of such products. However, today with the changing emphasis towards developing resource-based industries there is greater concern for secondary manufacture of primary products. Thus priority was given by the government to encourage investment and joint ventures in the country, mainly aimed at encouraging the development of import substitution and high value-added agro-based industries.

As emphasized by the historical background and development of the establishment of government backed R & D institutions in Malaysia, it is obvious that the major portion of R & D activities was targetted to primary agricultural product development and the end-users of the research results of the institutes were clearly identified and were reachable directly through the extension facilities available through the agencies responsible for the development of the sectors. Therefore the main activities of these research institutes at that time was concentrated on the transfer of research results to the targetted groups with little emphasis on commercial exploitation of such results. To a great extent this still holds till today. Furthermore institutions like RRIM, PORIM which are funded by cess drawn on their products are committed to make available their research results to the

contributors of the cess which is collected for R & D activities in the institutes.

Most of MARDI's research results are geared towards the agricultural sector especially to the small scale farmers to enable them to diversify into the cultivation of various crops and increase their productivity, to satisfy the socio-economic target of the New Economic Policy of the country i.e. namely the eradication of poverty and the equitable distribution of income.

With the industrial thrust in the country emphasizing the shift from basic agricultural activities to industrialization and mass production, research institutes are now concentrating more on the industrial type research. The strategy for encouraging resource-based industries will involve emphasis in secondary processing of the primary products and the development of value-added end products. With the introduction of mass production techniques, problems of adaptation of the newly acquired technology are becoming prominent. Applied research is now being carried out by institutes such as SIRIM whose main emphasis is on manufacturing technology and facilitates the adoption, adaptation and modification of imported technologies to suit local conditions. Research institutes like PORIM, RRIM, FRI and MARDI are also giving emphasis to this issue. In view of the shift from activities supporting agricultural production to those supporting secondary and manufacturing sectors, research institutes are now finding that the extension services and technology transfer activities are not adequate for effective technology transfer and should be augmented by employment of

commercialization concepts. The application of this concept of commercialization of research results will provide the means for rationalization of the links between the research institutes and industry. The essential linkages that are required for commercialization of research findings will entail the setting up of mechanisms to facilitate:-

(1) finding partners from the industry to sponsor research in R & D institutes;

(2) identifying research projects that are industrially applicable and demand orientated;

(3) accentuating on pilot plant feasibility studies and ironing out bottlenecks in manufacturing technologies;

(4) providing for further development of research findings;

(5) looking into the protection of invention through patenting and the need to encourage licensing and other contractual arrangements.

Attention is also given to new methods of identifying research areas that can result in technology appropriate for use in the country.

Although there is a general awareness by research institutes that they should go into commercialization of research results, presently the mechanisms for commercialization of research results in the country are not developed yet, though these institutes have been playing a very prominent role in transferring the technology

by extension and information dissemination through publication of research results in the past and have achieved success in enhancing agricultural production. This is seen by the achievements that the country has made in the production of rubber and palm oil making Malaysia a major supplier of these commodities.

This awareness of the importance of commercialization of research findings by the Ministry of Science, Technology and Environment is translated into the incorporation of a mechanism for commercialization of research results by the Standards and Industrial Research Institute of Malaysia (SIRIM). This is a pioneer approach towards resolving difficulties existing in SIRIM to effectively exploit its readily available research results into commercially viable enterprises. SIRIM has been an industrial research institute since 1975 and it is involved in numerous research projects. Its main channel of transferring of technology has been through consultancy services and publications and dissemination of research results to the industry. Though the transfer of research results from joint research activities has not been faced with problems of seeing these research results realized into commercial exploitation, SIRIM does face the problem of commercialization of research results from in-house projects which have been undertaken and which are awaiting for exploitation. These in-house research projects are identified by the Research Committee comprising representatives from government institutions and ministries and the private sector. Such research are solely financed by government

grants or through the institute's annual budget or bilateral or multilateral technical assistance. These research results are generally extended to the industries and relevant government agencies through information dissemination and publication of research results and through extension and consultancy services, of SIRIM to the small and medium scale industries. Most of these research results do not go through the normal stage of pilot plant studies and new processes or projects are not fully tested for their commercial viability. A severe limitation in the application of research results is the absence of available funds for carrying out of pilot plant scale studies and trial production runs to test and evaluate the commercial viability of such projects. The institute currently provides industry with technical consultancy services at nominal charges as the only system for extending the results of its research. A recent study by the institute on the factors that influence the industries' reluctance to take up research findings are:-

(1) high risk that will be faced by the industries that take up the research results which have not been tested through the pilot plant stage;

(2) there is little financial assistance to sponsor the take up of such research;

(3) the absence of specific incentives to encourage industries to venture into new technological areas so developed;

(4) the lack of thorough techno-economic feasibility studies before the research projects are conducted;

(5) arising from a wide and diversified industrial base it is difficult to identify and match the industrial client or user for the research. This is due to a lack of a mechanism to link the research findings and the services provided by the institute to the appropriate industries;

(6) research results of the institute are not protected by patents and there is no contractual or licensing provision in the activities of the institute to guarantee that the entrepreneur who is successful in the exploitation of the research results will be protected.

These are the major factors that have led to the reluctance of entrepreneurs to exploit the research results of the institute. Faced with these problems it has been proposed that SIRIM establishes a commercialization unit that will enable the industry to have easy access to technological developments. The commercialization unit will have the following functions and objectives:-

(1) to ensure that research findings are properly documented and patented, if necessary, for commercial transfer to industry;

(2) to act as a body which administers the licensing of research findings to the industry;

(3) to encourage industry to sponsor pilot plant studies with proposals to government to give incentives on expenses incurred;

(4) to have closer rapport with industry to ensure that research projects selected will be oriented to problem solving of industries needs;

(5) to promote the utilization of new indigenous technologies contributed by SIRIM;

(6) to undertake drawing up of joint research contracts and to establish technical cooperation with local or foreign bodies;

(7) to provide information and advisory services to industry on choice of technology;

(8) to establish close relationship with other research bodies and act as a technology transfer agent.

With the implementation of the above it is hoped that the links between SIRIM and the industry will be strengthened and that research activities will be geared towards industrial needs and commercial exploitation.

4. IDENTIFICATION OF COMMON BOTTLENECKS IN THE PROCESS OF COMMERCIALIZATION OF RESEARCH RESULTS

The main problem of commercialization of research results lies with the traditional practice of research institutions that leave the development of research results to the extension unit or to consultancy services whenever there are enquiries from the potential technology users. On the national level even though over the past years commercialization of research results have been discussed, however the reorientation of research institutions' activities from that of basically transferring technology which are results of research to that of actually earning revenues from such research results from licensing is still a new approach.

Furthermore there are various bottlenecks at the national level that hinder actual commercialization of research results such as

(1) the national economic policy and guidelines stress on the need to help the development of small scale farmers and the small and medium scale industries. Research projects are mainly concentrated on complementing such an objective as small scale industry and small scale farmers do not possess the necessary resources to finance research and the government has to give them a helping hand. Therefore as a matter of fact the research results are fully utilized for technology transfer to these targetted groups though there is little economic returns to the institute. Large capital-based industries in the country and plantations are supported by their own research activities and are able to tailor their research direction to satisfy their own needs. Therefore multinational companies do not have the pressing need to take up R & D locally and usually are not interested in entering into joint research activities by making use of facilities of the local research institutes. Furthermore there is easy access to foreign technology and favourable fiscal encouragement by the government to importation of technology by those that can afford to buy such technologies. Therefore medium scale and large scale industries prefer to import technologies and technological packages from abroad rather than to join hands with the governmental R & D institutes to go into research. One major bottleneck

in the generation of local technology and its dissemination to industries is that many transnational companies and large industrialists have a preference for purchasing directly complete packaged technology or to enter into a turn key type project agreement. Such an approach would provide an easier accessibility to proven technology in which the major risk factors have been eliminated, although at a very high purchase cost. This therefore makes it difficult for local research institutes to influence the industrialists to undertake specific projects which are aimed at improving or developing parts of processes or systems, as the general practice is towards accepting complete manufacturing systems in the package i.e. design, machinery, process and including franchise.

(2) Commercial banks and financial institutions in the country are not required to give soft loans or incentives to entrepreneurs venturing into the commercial development of research results which by nature are of high risk to the entrepreneurs. Though research institutions provide technical expertise and guidance for potential users of the research results, these institutions are not usually involved in the development of their own research results and the involvement of such research institutes are not specified in the functions of the institutes. Development of research results into actual application is either left to government agencies or ministries in charge of the research institutes through their own extension units which have direct linkages to the industry. In the case of the

Ministry of Agriculture, the Agriculture Department has been successful in translating the research results into practical applications of most of the agricultural research institutes. However, in the case of industrial research results there is an absence of a transfer agent with the necessary linkages to the appropriate industries.

As explained earlier much of the research carried out by research institutes is mainly directed to small scale industries which have low absorptive capabilities because they have no technical expertise and wherewithall and the transfer of research results to such groups require the interplay of other supporting facilities and developing of other mechanisms.

(3) The patent system in the country which is based on the re-registration of patents already granted by the United Kingdom is a hindrance to the development of R & D activities in the country. Local inventions have to undergo the expensive and burdensome procedures of applying for patents in the United Kingdom first before this patent can be re-registered in Malaysia. Most research institutions prefer to publish the results of research rather than to go through the expense of patenting the research results. In 1980 less than 2% of the applications for re-registering of patents in the country were from local applicants.

(4) Results of industrial research projects have to be subjected to trial production runs or pilot plant phase in order to cut down the risk factor before commercialization. Research

institutions are usually restricted by budgetary allocations from going into the trail production run phase or pilot plant phase. Therefore entrepreneurs generally are reluctant to take up the projects.

5. WAYS AND MEANS TO COPE WITH THE BOTTLENECKS

With the emphasis of the industrialization thrust it is imperative that research organizations concentrate on buying technology and devising effective and efficient mechanisms for the transfer of such technologies directly to the industry. It is also necessary that industries be prepared to readily absorb the new technology.

On the national level the shift in emphasis into applied technological research has been given recognition by the Ministry of Science, Technology and Environment, the National Science Council and the Coordinating Council for Industrial Technology Transfer whereby the necessary infrastructure and plans to enhance this move by the research institutes are being developed. These include:-

(1) the formulation of the National Technology Transfer Policy to enable the identification of priority industrial sectors and the role of technical research institutes towards the development of the priority industries and the necessary mechanisms that should be established or strengthened to support the transfer of research results from such institutes.

(2) the formulation of the National Science Policy to identify appropriate research areas to cater for the present development

of the industrial sector and also to anticipate its future growth.

(3) the establishment of technology information system and network with the initial setting up of a Patent Information and Documentation Centre (PIDC) in SIRIM to strengthen technology bargaining power and choice of technology by the industry and also to give new direction to research projects by providing information on available research results and state-of-the-art of patented technologies. It is intended that the PIDC will be the basis for the establishment of a national technology information network.

(4) the setting up of an infrastructure for commercialization of research results in SIRIM as an initial step towards the encouragement of the setting up of similar mechanisms in other research institutes.

(5) the recognition of the need to set up a Technology Transfer Centre as a clearing house at national level for the promotion, dissemination and transfer of indigenous and imported technologies to the industrial sector, supported by the development of specific technology resource centres such as MITEC, MIRDC of SIRIM and other identified sectors to cater for priority or targetted industries identified under the Industrial Master Plan.

(6) the establishment of an indigenous industrial property system in the country to supersede the former system of re-registration of industrial property will help to encourage research institutes to apply for patents at the most economical cost and facilitate the speeding up of patenting procedure for local applications, thereby increasing local innovative spirit. It is hoped that with this new patent system the research results will be better protected thereby encouraging licensing and contractual procedures between research organizations and the targetted priority sectors for purposes of enhancing commercial development of research results.

6. LONG TERM STRATEGIES FOR COMMERCIALIZATION OF RESEARCH RESULTS

One long term strategy for the commercialization of research results is the development of technology transfer corporations to provide package transfer of technology to the small and medium industries in Malaysia. In view of the plans and strategies that are being devised by the government to encourage commercialization on the short term, commercialization activities are only concentrated in research institutions. However, there has been discussions on the long term plans for commercialization of research results in the country. One of the current proposals that is being examined by the National Council for Scientific Research and Development is the establishment of a body incorporate with linkages to the various research institutes and the industries to facilitate the transfer of such research

results efficiently. This type of technology transfer corporation would mainlybe limited to the transfer of technology packages and therefore concentrate on imported technology which is adopted for local application.

As a result of government's current strategies to strengthen the activities of research institutes to develop commercialization of research results, it is envisaged that in the long term various strategies would need to be adopted such as:-

(1) the setting up at national level a technology transfer corporation to serve as a focal point and clearing house for both indigenous technologies and imported technologies that are modified and adapted by local research institutes into a package suitable for easy translation into commercially viable undertaking. Technical support will be given by the research institutes in Malaysia to this corporation and the function of this corporation will be to set up companies in joint venture with the industries utilizing the newly acquired technology.

(2) In view of the low absorptive capability of the small and sometimes medium scale industry, research institutes will have to strengthen their technical consultancy services and training facilities with the objective of upgrading the technical skills of these industries. This can be initiated by the implementation of industry adoption schemes whereby companies are assisted on an integrated basis to acquire new technology and develop their know-how at the management, process and product development levels.

(3) Devising a firancial support infrastructure for soft loans and other financial incentives to encourage industry to upgrade and modernize their facilities by using the latest technologies developed.

(4) To encourage industries (especially the small scale industries) which do not have readily available research facilities, to organize themselves into specific industrial groups (e.g. Industry Research Associations). These groups will be organized along common frontiers, to bring together the common technical problems faced by these industries, and which can cooperate to sponsor research to solve these problems. These may jointly refer to the facilities available at government research institutes to assist them to overcome their common problems. Finance for these research activities will be funded by joint contributions by these groups.

7. CONCLUSION

To summarise, I would like to reiterate that Malaysia previously focussed its attention more on the research of its primary industries and the extension of these research findings to the industries for direct implementation and not for commercial exploitation as such. However, in the course of industrialization and economic progress. these extension and consultancy services have been found to be inadequate and the need for commercialization of research findings have been acknowledged. Recently the government has drawn up new plans and policies to assist commercialization of research findings and technology and hope that in the next few years this commercialization of research results would be realized.